We gather from the above report that on this occasion the principal phenomena observed were: (1) A distinct and perfect rainbow partially encircling the zenith, and so high above the moon as to be "almost in the zenith." (2) A beautiful cross of horizontal and vertical bars of a bright light yellow intersecting each other on the face of the moon. (3) Two similar fainter crosses at about 15° to the right and the left of the moon.

The general explanation of optical phenomena seen about the sun and moon was given on page 14 of this Review for January, and page 56 of this Review for February, 1895. (1) The arc of colored light or horizontal rainbow concentric with the zenith is caused by rays of sunlight that enter and leave the little vertical prisms of ice that are slowly settling down through the atmosphere. The top and bottom facets or faces of these crystals are inclined to each other and the refraction through these faces produces prismatic colors just as in an ordinary prism. The diameter of the rainbow circle around the zenith is smaller in proportion as the sun or moon is higher above the horizon. (2) The large cross of light yellow bars is due to the simple reflection of the moonlight from the outside facets of innumerable crystals of ice, all of which are slowly settling with their axes vertical. (3) The small and fainter crosses on either side of the moon are due to two reflections from the interior surfaces of crystals.

A complete study of the phenomena of parhelia can be made by preparing a number of hollow prisms made in the exact shape of the crystals of snow and ice that occur in nature. These prisms should be made of thin plates of glass cemented together at the edges, and should be filled with water, whose refractive and dispersive powers are of course very nearly the same as those of ice. Let such a prism be suspended in the sunlight in various positions with reference to the zenith, and in the position that it assumes when falling slowly through the air. Set it to revolving rapidly, as it may do when falling freely. If a special bright reflection is seen when viewed from a certain direction then this represents the position of a mock sun due to total reflection within the prism. If prismatic colors are seen this represents the position of a rainbow. If a moderately bright reflection from an external surface is seen this gives the location of some one of the numerous bands of light that may occur.

THE COLD SUMMER OF 1816.

An article in the New York Sun copied into the Iowa Monthly Review for July, 1895, gives some details about the remarkable summer of 1816, as remembered by James Winchester of Vermont. It is said that in June of that year snow fell to the depth of three inches in New York, Pennsylvania, and New Jersey on the 17th; five inches in all the New England States, except three inches in Vermont. There was snow and ice in every month of this year. The storm of June 17 was as severe as any that ever occurred in the depth of winter; it began about noon, increasing in fury until night, by which time the roads were impassable by reason of the snow drifts; many were bewildered in the blinding storm and frozen to death. During June, July, and August the wind was continuously from the north, fierce and cold; July was colder than June, and August colder than July; there was a heavy snowstorm August 30th. The first two weeks in September brought the first warm weather of the year, but on the 16th of that month the cold weather suddenly returned and continued increasing until winter. The year 1816 had neither spring, summer, nor autumn. The only crop of corn raised in that part of Vermont that summer was saved by keeping bonfires burning around the cornfield night and day. The crop of 1817 was raised from the seed of 1815. The summer of 1817 was one of the hottest and driest ever known in that region.

Note.—The preceding statement agrees with what we may gather from the interesting book by Charles Peirce, published in Philadelphia in 1847, entitled "A Meteorological Account of the Weather in Philadelphia," from January 1, 1790 to January 1, 1847. A record was begun by Peirce, at Portsmouth, N. H., in 1793, and was continued in Philadelphia, where he had access to numerous other journals. According to this work the mean temperatures at Philadelphia during the year 1816 were the lowest on record, and were as follows: January, 32°; February, 28°; March, 36°; April, 47°; May, 57°; June, 64°; July, 68°; August, 66°; September, 62°; October, 52°; November, 42°; December, 32°.

On page 247 Mr. Peirce says:

The temperature of the whole year was only 49°, it being the coldest year we have on our record. Although there was no uncommonly cold weather during the three winter months, yet there was ice during every month in the year, not excepting June, July, and August. There was scarcely a vegetable came to perfection north and east of the Potomac. The cold weather during the summer not only extended through America, but throughout Europe. One of the most celebrated meteorologists in England, on reviewing the weather of the year, said: "It would ever be remembered that 1816 was a year in which there was no summer, and the temperature of the year (as a whole) was the lowest ever known." It was also the coldest summer ever known in the West Indies and in Africa. The medium temperature of the whole year in Philadelphia was only 49°.

A POPULAR SUBSTITUTE FOR THE BAROMETER.

In The Weather and Crops, published by the Illinois State Weather Service, we find a short description of a simple instrument that serves the purpose of showing approximately the changes that may be going on in the pressure of the air. The description reads as follows:

If a large-mouthed glass jar—fruit or pickle jar will do—be filled about two-thirds full of water, and in it be placed, inverted, a smaller long-necked flask, with mouth entering the water, the increasing or decreasing pressure of the outer atmosphere will cause the water to rise or fall within the flask. Clear, fine weather will be foretold by the water rising in the flask; stormy, wet, or bad weather by the water falling.

The device thus explained will, undoubtedly, show variations in atmospheric pressure, and all the more correctly in proportion as the temperature of the air within the flask remains stationary. If we wish to be at all accurate, or if we wish not to be misled by the effects of changes of temperature we must either keep the temperature constant or else make a numerical allowance for the effect of its variations. If the temperature within the flask rises 1 degree Fahrenheit, its confined air will expand by $\frac{1}{492}$ of its volume, and the water in the neck of the flask will be pushed down to a corresponding amount. On the other hand, if the atmospheric pressure should diminish by 0.06 of an inch below a normal pressure of 30 inches, the air within the flask being slightly relieved of its pressure would expand by the $\frac{1}{492}$ part of its volume, and the water in the neck pushed down as before. In so far as we cannot rely upon the constant temperature of the air within the flask we must therefore make an allowance of 0.06 for each degree of change. As this apparatus is so sensitive to temperature it may therefore be considered as a thermometer when the atmospheric pressure is constant. In fact this is known as the first form of air thermometer which was used by the physician Sanctorius, who learned it from Galileo in 1596, and it was the study of the fluctuations of this apparatus that contributed greatly toward the discovery of the pressure of the air and the invention of mercurial barometers and the ordinary spirit thermometer. If one wishes to use this apparatus as a barometer, and needs, therefore, to know its temperature correctly to within a degree, he will find it best to fasten the smaller flask and its long neck, or, still better, a long glass tube, permanently within the outer glass jar and fill the latter with water so that the whole flask is cov-